CLAIMS

What is claimed is:

1. An apparatus for determining the diffusion length of semiconductor wafers comprising:

a probe for directing radiation on an area of back side wafer surface to excite charge carriers, create and detect a surface photovoltage, said probe including an electrode, said electrode including a transparent element placed on surface of the electrode in the path of said radiation, and a non transparent element surrounding said transparent element, said electrode is placed in proximity to the back side of the wafer,

means for illumination of the surface at different wavelengths, including two or more different sources of monochromatic light driven by light drivers controlled by a computer,

means for directing light flux onto said electrode of the probe and a photo detector;

means for measuring surface photovoltage (SPV) signals picked up by said electrode, said means for measuring including SPV pre-amplifier and lock-in amplifier with said electrode connected to the input of said SPV pre-amplifier, the output of said SPV preamplifier connected to the input of said lock-in amplifier and the output of said lock-in amplifier connected to said computer,

means for measuring light flux including a pre-amplifier with said photodetector connected to the input of said pre-amplifier and the output of said pre-amplifier connected to said computer,

an optical system installed from the front surface of the wafer coaxially with said transparent element, said optical system being designed for pattern recognition, said optical system including an objective lens and a CCD matrix with said CCD matrix output connected to said computer,

means for positioning said optical system coaxially with said electrode, and

means for wafer positioning using measurements in different locations including one or more linear stages and a rotary stage, said linear stages and said rotary stage controlled by said computer.

2. The apparatus as in Claim 1, wherein the transparent element is a transparent glass or quartz disk, said transparent disk having a conducting coating on its top and side surfaces, said transparent disk being installed inside a metal ring with a diaphragm covering a part of said transparent disk excluding a central region.
3. The apparatus as in Claim 2, wherein the diameter of said central region is in the range 0.1-1 mm and outer diameter of the metal ring is 8-10 mm.
4. The apparatus as in any one of Claims 1-3, wherein means for illuminating wafer surface includes laser diodes installed in an optical combiners, said optical combiners coupled with optical fibers.

5. The apparatus as in any one of Claims 1-4, wherein the means for directing light flux onto said electrode of the probe includes a Y shaped optical fiber, with one end of the optical fiber connected to an optical collimator installed in proximity with said optical element, and the other end of the optical fiber is connected to the photo detector.

6. The apparatus as in any one of Claims 1-5, wherein said apparatus further comprises:

a second probe for directing a second radiation on an area on the back side wafer surface to excite charge carriers, create and detect a surface photovoltage from back side of the wafer, said second probe including a second electrode including a second transparent element and a second non-transparent element, where said second transparent element is placed on the path of said second radiation and said second non-transparent element surrounding said second transparent element, said second electrode is placed in proximity to the back side of the wafer,

a second means for illumination of the back side of the wafer surface at different wavelengths, including different sources of monochromatic light driven by light drivers controlled by said computer,

a second means for directing light flux onto said second transparent element of said second electrode of the second probe and a second photo detector,

a second means for measuring surface photovoltage signals picked up by said second electrode including a second preamplifier and a second lock-in amplifier with said second electrode connected to the input of said second preamplifier input, the output of said second preamplifier connected to the input of said second lock-in amplifier and the output of said second lock-in amplifier connected to said computer, and

a second means for measuring light flux including a third preamplifier, with said second photo detector connected to the input of said third pre-amplifier input and the output of said third pre-amplifier connected to said computer..

7. The apparatus as in Claim 6, wherein the second transparent element of the second probe is a second transparent glass or quartz disk, said second transparent disk having a transparent and conducting coating on its top and side surfaces, said second transparent disk installed inside a second metal ring.

8. The apparatus as in Claim 7, wherein the diameter of said second transparent disk is in the range 1-7 mm and outer diameter of the second metal ring is 8-14 mm.

9. The apparatus as in any one of Claims 6-8, wherein said second means for illuminating the wafer surface includes light emitting diodes with interference optical filters, said LED's coupled with optical fiber bundles.

10. The apparatus as in any one of Claims 6-9, wherein the second means for directing light flux onto said second transparent element of the second probe

includes Y shaped optical fiber bundles, where one of the end of these optical fiber bundles is coupled with said second probe and the other end of the optical fiber bundles splits light flux between said second transparent element of said second probe and said second photo detector.

11. The apparatus as in any one of Claims 6-9, wherein said apparatus includes two or more SPV units used for said apparatus throughput improvement.

12. A method for determining diffusion length in predetermined regions of the wafer, comprising:

positioning a wafer, using a pattern recognition means, to get the predetermined region of the wafer over an illumination area on a back side wafer surface,

illuminating said area on the back side wafer surface with frequency modulated light with predetermined intensities at a series of wavelengths, λ_i, measuring light fluxes Φ_i directed onto said illumination area and measuring photovoltages V_i from said illuminating area;

illuminating said area at different intensities at the same wavelength λ_1, measuring light fluxes Φ_1 and Φ_{11} and corresponding surface photovoltages V_1;

recalculating SPV signals using the formulas:

$$C_{NL} = \frac{V_{11} \cdot \Phi_1^2 - V_1 \cdot \Phi_{11} \cdot \Phi_1}{V_{11} \cdot \Phi_1^2 - V_1 \cdot \Phi_{11}^2}$$

$$V_i^L = \frac{1 - C_{NL}}{1 - C_{NL} \cdot V_i / V_1} V_i$$

determining diffusion length using values Vi^1, Φ_i and intercept of the plot Φ_i / Vi^1 versus light penetration depth.

13. The method as in Claim 12 wherein the wafer is positioned using pattern recognition system to get the predetermined region of the wafer within scribe line over the illumination area on back side wafer surface.
14. The method as in Claim 12, wherein light wavelength are in the range 800-1000 nm.
15. The method as in Claim12, wherein light modulating frequency is in the range 400-5000Hz.
16. The method as in Claim 12, wherein multiple SPV probes are used simultaneously.